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Gibbings, Alison and Vasile, Massimiliano and Watson, Ian A. (2013) *Deflecting and exploring asteroids with lasers.* In: University of Strathclyde Research Day 2013, 2013-06-07 - 2013-06-07, Glasgow.

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DEFLECTING AND EXPLORING ASTEROIDS WITH LASERS

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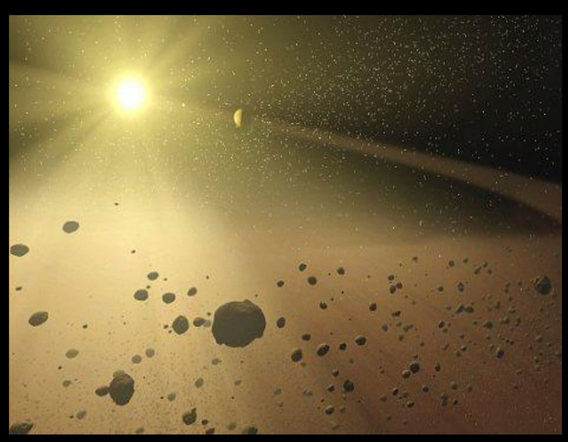
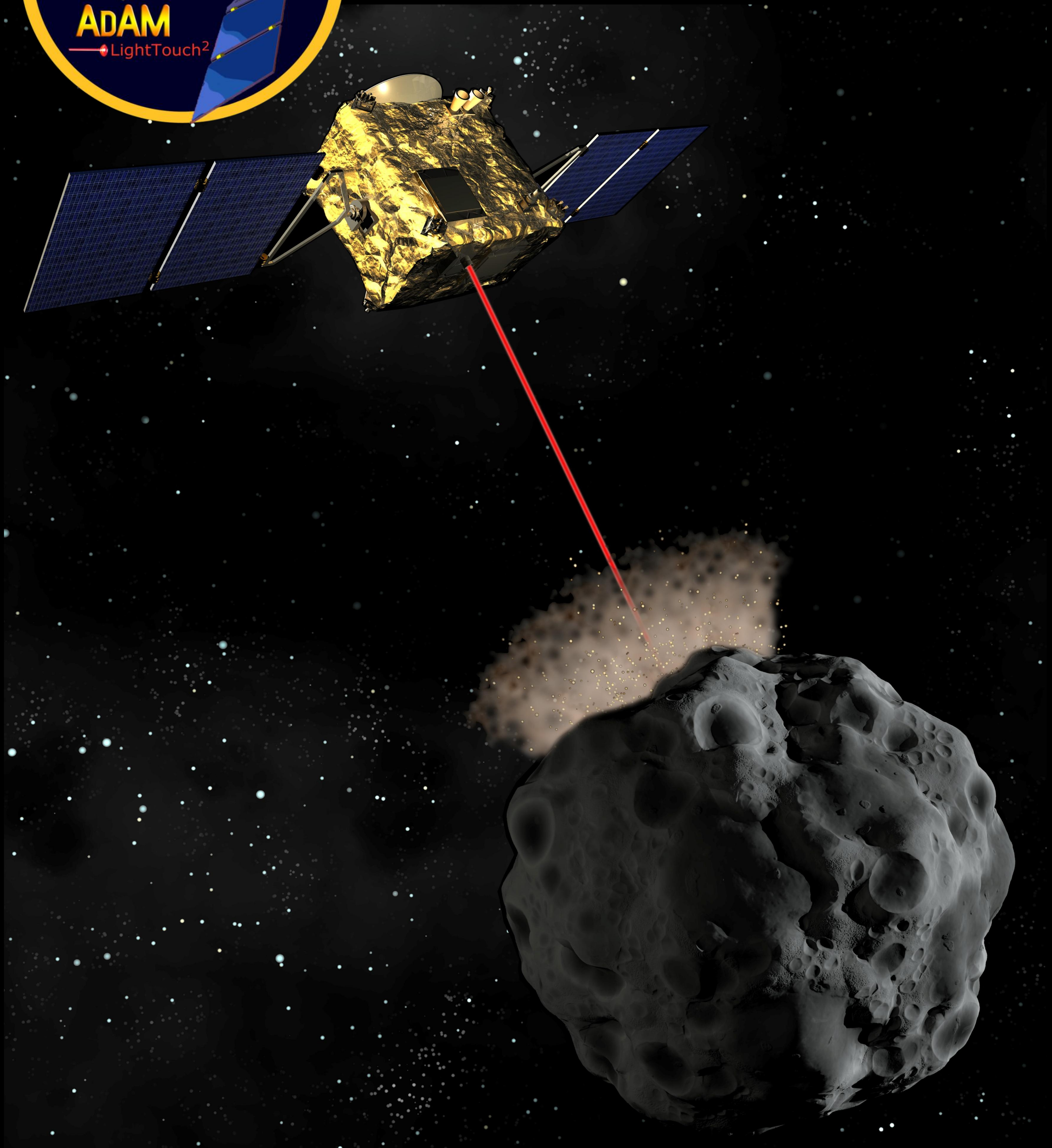
ASTEROIDS

Asteroids, the rocky remains from planetary accretion, represent both an opportunity and a risk. Their pristine environment captures the early impact evolution of the solar system, whereas their impact potential could result in the mass extinction of life. To address this combined theme, laser ablation has been investigated as a novel technique for the deflection and exploration of asteroids.



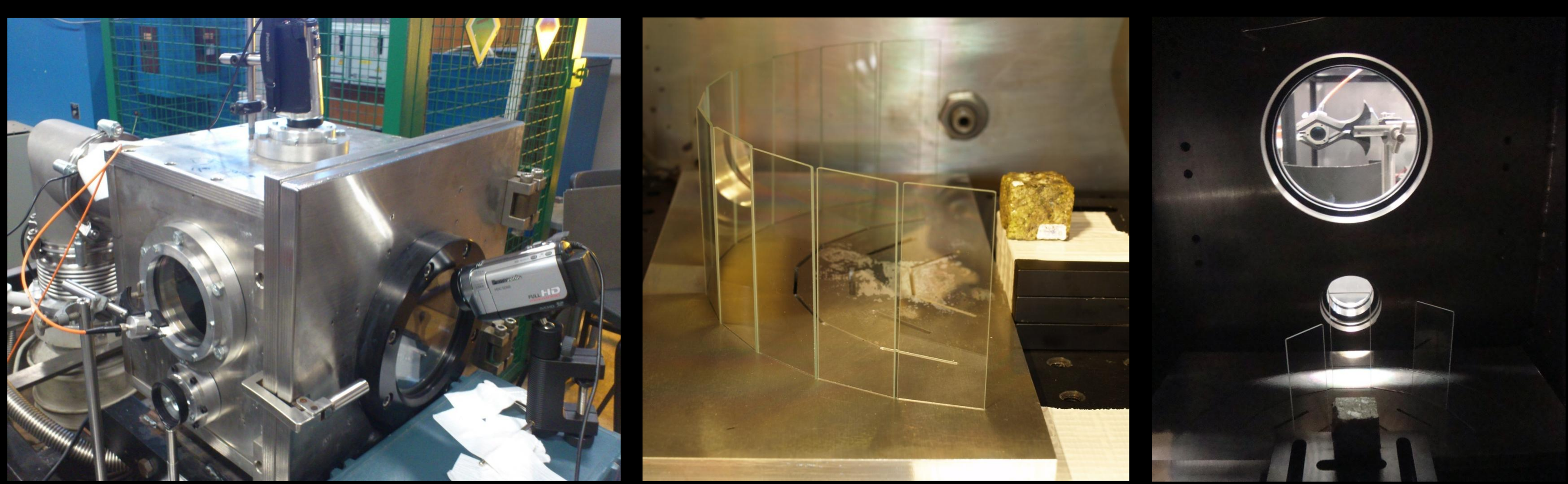
Laser ablation is achieved by irradiating the surface of an asteroid with a laser light source. The resulting heat sublimates the surface material, transforming the exposed material directly from a solid to a gas. The ablated material then expands to form into a small and extended plume of ejecta. Over an extended period of time, the ejecta plume acts against the asteroid. This provides a continuous, yet controllable low-thrust push that can be used for the deflection, manipulation and exploration of small and medium size asteroids.

Mission studies have recently demonstrated the capability of relatively small, yet highly efficient space-based laser systems. It has also verified the laser's proof-of-concept, the spacecraft's preliminary mission design & the feasibility of its in-space application.

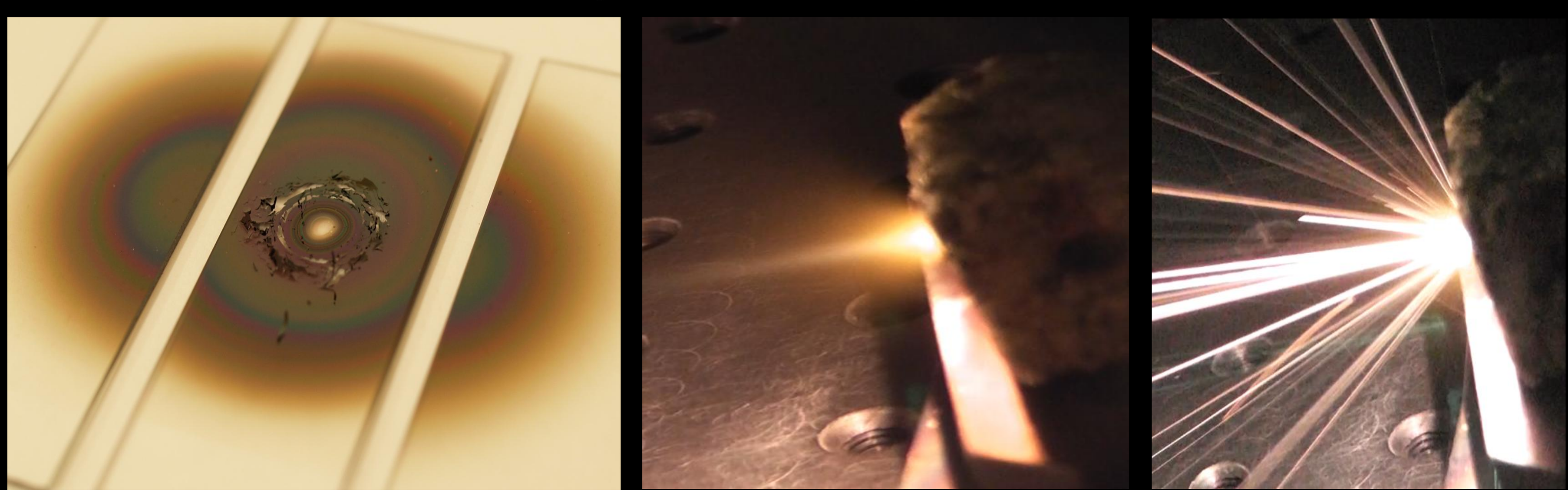


ABLATION EXPERIMENTS

In vacuum, a 90 W continuous wave laser beam has been used to re-create the asteroid-to-laser ablation event. Assessed parameters included the mass flow rate, temperature and velocity of the ejecta plume and the height, density and absorptivity of the deposited ejecta.



Design - Laser Ablation Experiments



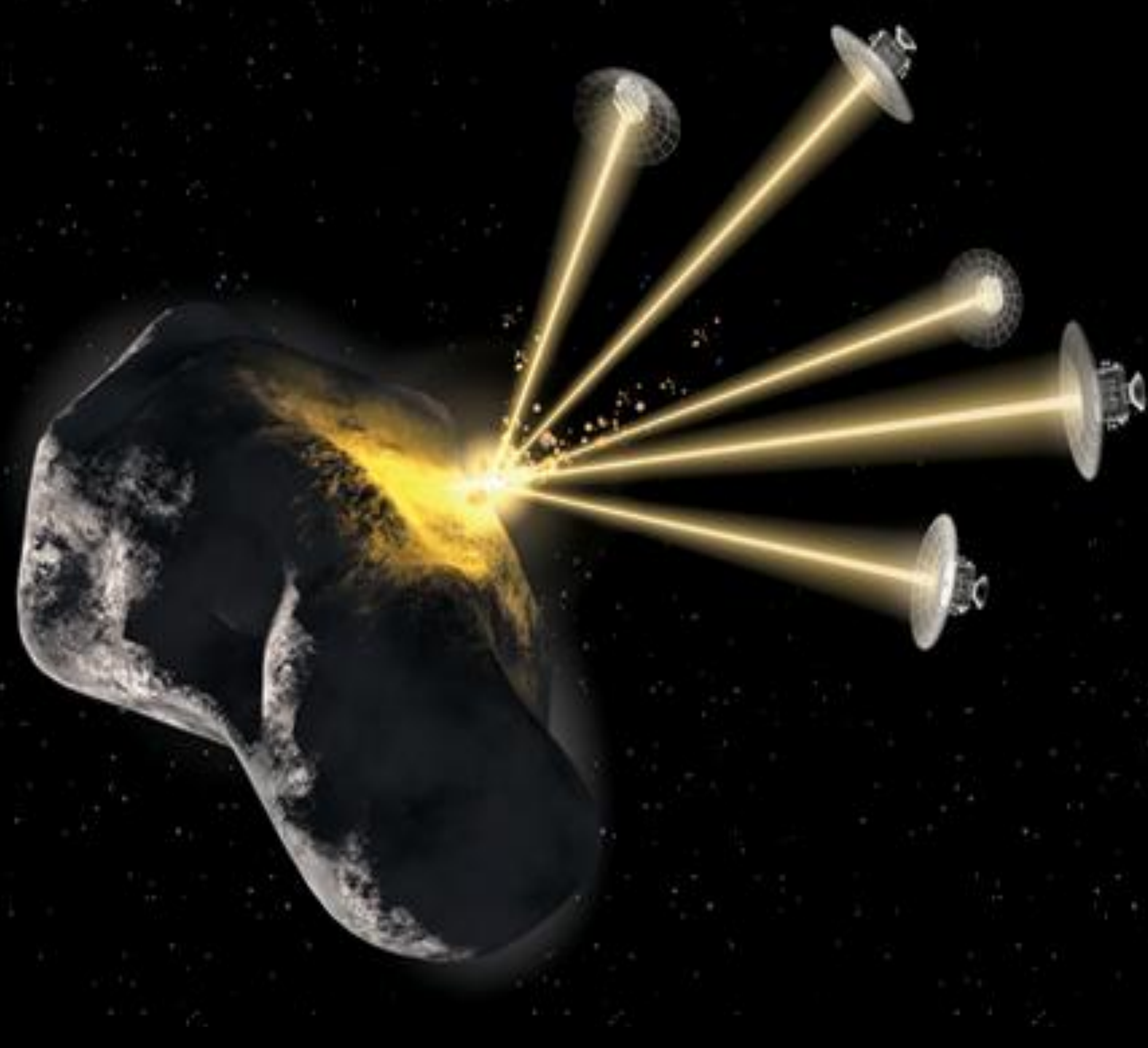
Results - Laser Ablation Experiments

Laser ablation resulted in the initial, volatile and hemisphere ejection of small, yet solid particles of ejecta. Gaseous material was also ejected. The contamination caused by the deposited ejecta was also found to be significantly lower, and loosely bound to the underling substrate. These results have enabled specific advancements within the ablation model to be considered. This included the energy absorption within the target material, the formation of the Knudsen layer and the incongruent ablation of the target material.

OPPORTUNISTIC SCIENCE

Experiments have shown that laser ablation results in the subsurface tunnelling and volumetric removal of deeply situated and previously inaccessible material. This is due to the formation of a subsurface groove and the ejection of highly volatile material. Laser ablation can therefore be used to expand and maximise the capabilities of any remote sensing, in-situ and/or sample return mission. It would enable scientists and engineers to further characterise the composition, formation and evolution of asteroids, and other rocky bodies distributed throughout the solar system.

Laser ablation can also be used for the commercial exploitation and exploration of asteroids. A self-sustaining space economy could be provided by the capture and harvest of asteroids within an Earth-bound orbit. Extracted material can be used for in-situ space construction, the formation of deep-space propellant deposits and provide continual life-support for future human exploration.



Laser Ablation Offers a Unique Opportunity

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